

Airvolt

Aamod Samuel
Yohan Lin



Testing

- Build Up Test Approach
 - Test often and integrate segments early
 - Use full length cables
 - Ensure best practices implemented and verified
 - Grounding/shielding
 - Calibration verification
 - Software/hardware integration
 - Structural modes
 - Manual safety, auto shutdown, software shutdown

Title

Testing

Test Flow

LAB: Bench

LAB: Function

LAB: Accuracy

LAB: Load Cell

GVT

GVT

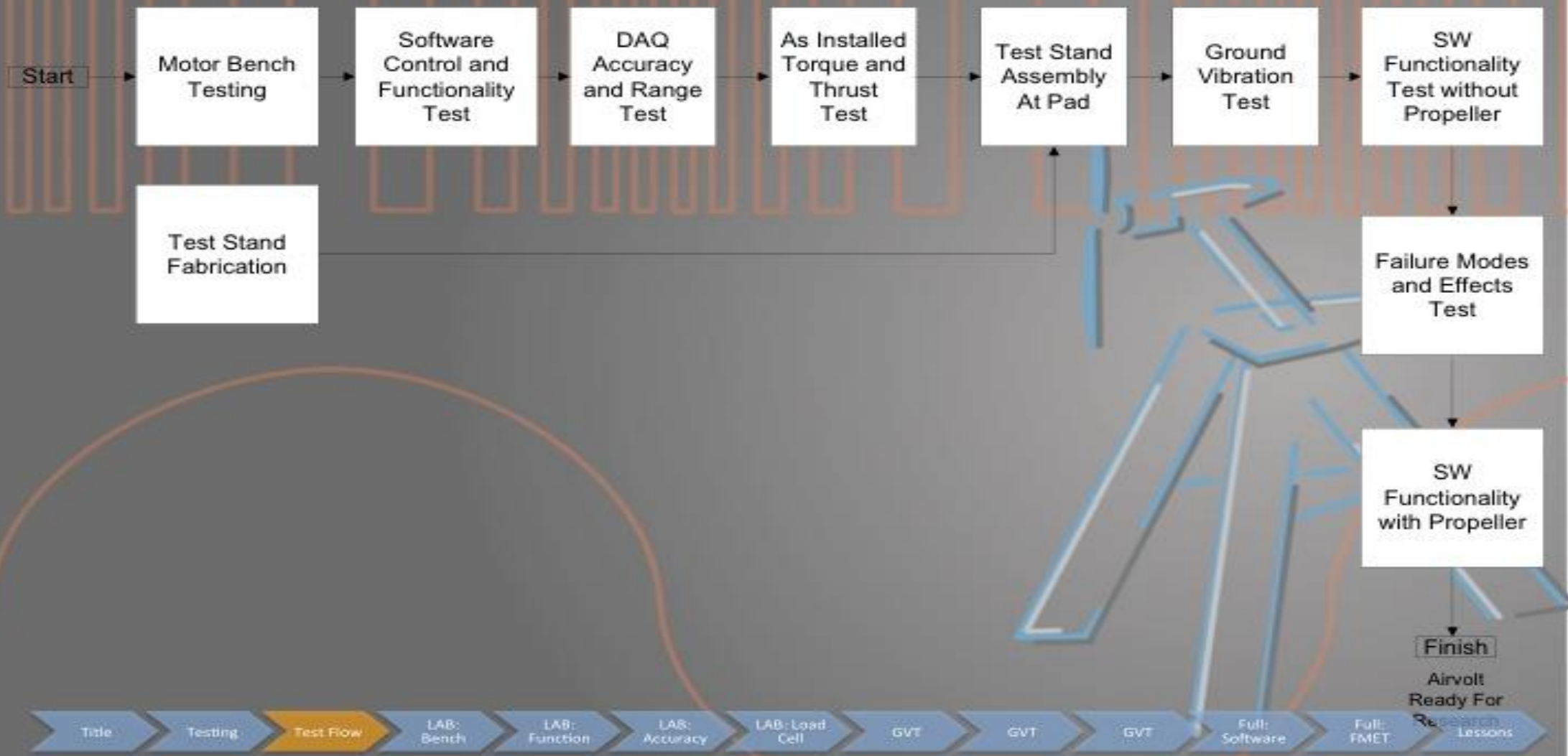
GVT

Full: Software

Full: FMET

Lessons

Test Flow



Bench Level Test

- Verify functionality
 - Control
 - Charging
- Better understand system



Title

Testing

Test Flow

LAB: Bench

LAB: Function

LAB: Accuracy

LAB: Load Cell

GVT

GVT

GVT

Full: Software

Full: FMET

Lessons

Software Control and Functionality

- Control with software
 - CAN Protocol
 - Test software command functions
 - RPM command
 - Canned profile
 - Built in Tests
- Utilizes full cable lengths
- Verifies sensors and their calibrations
- Lab hardware and software integration
 - Found issues with auto shutdown logic
- Gooseneck ground vibration/ping test with motor



DAQ Accuracy Test

- Verify each A/D channel is within requirement specifications
- Calibrator used to send test signal
 - Low, medium and high ranges tested
 - Air conditioner used
 - Temperature changes affect accuracy

Title

Testing

Test Flow

LAB: Bench

LAB: Function

LAB: Accuracy

LAB: Load Cell

GVT

GVT

GVT

Full: Software

Full: FMET

Lessons

Load Cell Test

- Verify installed configuration of thrust and load cell
 - Friction in thrust setup
 - Resulted in removing pillow block
 - Secondary support structure



Title

Testing

Test Flow

LAB:
Bench

LAB:
Function

LAB:
Accuracy

LAB: Load
Cell

GVT

GVT

GVT

Full:
Software

Full:
FMET

Lessons

Pad Testing: Ground Vibration Test

- Determine fundamental modes of structure
 - Data used to develop FEM model
 - Model can be used for new motor implementation



Title

Testing

Test Flow

LAB: Bench

LAB: Function

LAB: Accuracy

LAB: Load Cell

GVT

GVT

GVT

Full: Software



Full: FEMT

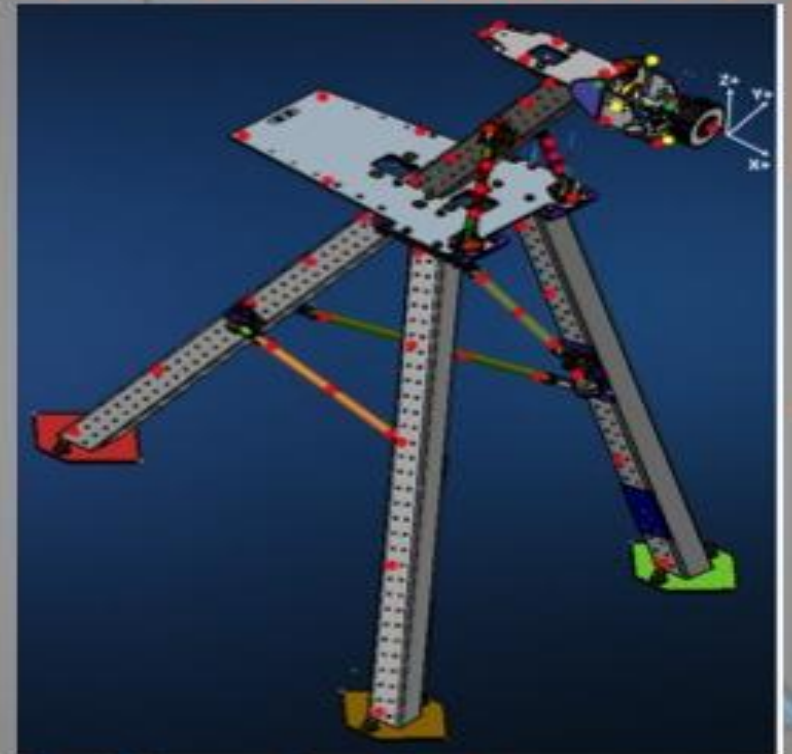
Lessons

Ground Vibration Test

- Test Setup
 - GVT conducted outside
 - Rigid boundary condition - test stand bolted to concrete pad
 - 55 accelerometer locations, measuring 165 accel responses
 - 3 shaker excitations locations

Locations, Directions & Sensor Types

- | | | |
|---------------|------------------------------|---|
| ● X, Y, or Z | Uniaxial, Endevco 7251A |  |
| ● X, Y, and Z | Triaxial, PCB T356A16 |  |
| ● X, Y, or Z | Excitation (Shaker & Hammer) | |



Ground Vibration Test

- Baseline Configuration Results
- Potential motor throttle settings of concern, “Dwell Keep Out Zone”
 - Motor throttle setting & GVT frequencies may vary due to propeller influence

Title

Testing

Test Flow

LAB: Bench

LAB: Function

LAB: Accuracy

LAB: Load Cell

GVT

GVT

GVT

Full: Software

Full: FMET

Lessons

Full Configuration Test

- With and without propeller
 - Use of control room
 - Identified EMI issues with propeller
 - Standard aircraft grounding and shielding processes implemented
 - More power draw
 - Data bias and noise
 - Affects auto shutdown
 - More testing underway to address/mitigate EMI issue



Title

Testing

Test Flow

LAB: Bench

LAB: Function

LAB: Accuracy

LAB: Load Cell

GVT

GVT

GVT

Full: Software

Full: FMET

Lessons

Failure Modes and Effects Test

- Identify weaknesses or deficiencies
- Verify safety features
 - Emergency software shutdown
 - Manual shutoff
 - Loss of communication link
 - Loss of power/ Uninterruptable Power Supply endurance



Title

Testing

Test Flow

LAB:
Bench

LAB:
Function

LAB:
Accuracy

LAB: Load
Cell

GVT

GVT

GVT

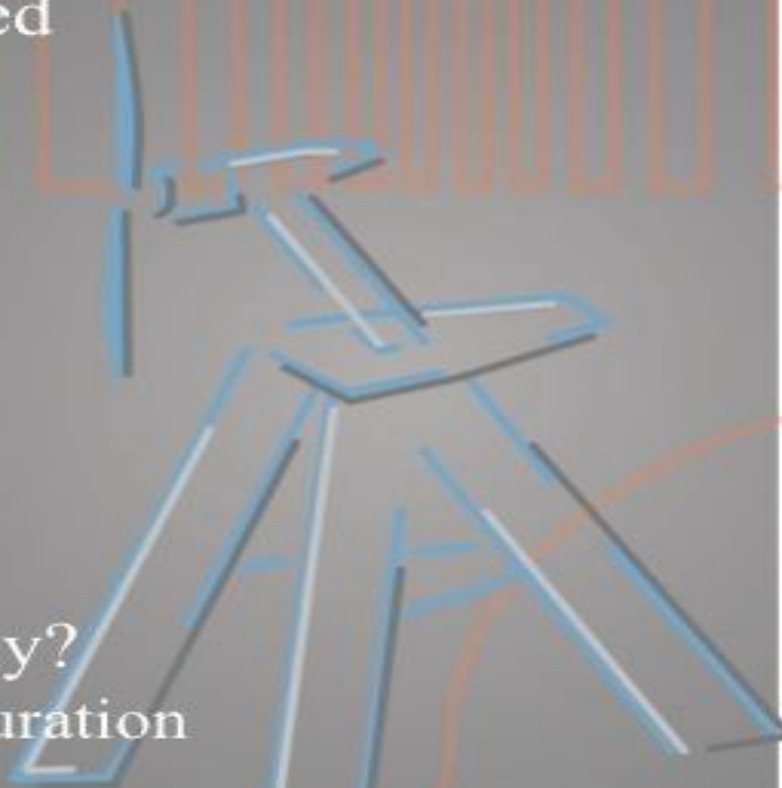
Full:
Software

Full:
FMET

Lessons

Lessons Learned

- Early testing on bench level identified
 - Incorrect calibration
 - Shutdown logic implementation
 - Incorrect wiring
 - Load cell friction within setup/design
- Full configuration pad testing
 - Determine structural modes
 - Safety shutdown systems
 - EMI issues
- What would we have done differently?
 - Apply load on motor in bench configuration



Title

Testing

Test Flow

LAB: Bench

LAB: Function

LAB: Accuracy

LAB: Load Cell

GVT

GVT

GVT

Full: Software

Full: FMET

Lessons